

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US04/043288

International filing date: 27 December 2004 (27.12.2004)

Document type: Certified copy of priority document

Document details: Country/Office: AU
Number: 2003907138
Filing date: 24 December 2004 (24.12.2004)

Date of receipt at the International Bureau: 30 May 2005 (30.05.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)



World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse



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PCT/US 04/43288

RO/US 10 MAR 2005

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I, JANENE PEISKER, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003907138 for a patent by COCHLEAR LIMITED as filed on 24 December 2003.

WITNESS my hand this
Twenty-second day of December 2004

A handwritten signature in dark ink, appearing to read 'J. Peisker'.

JANENE PEISKER
TEAM LEADER EXAMINATION
SUPPORT AND SALES



AUSTRALIA

Patents Act 1990

Cochlear Limited

PROVISIONAL SPECIFICATION

Invention Title:

Transformable speech processor system

The invention is described in the following statement:

Field of the Invention

The present invention relates to a hearing prosthesis, in particular, a cochlear
5 implant hearing system.

Background of the Invention

Cochlear implant hearing systems deliver electrical stimulation to the auditory
10 nerve fibres thereby allowing the brain of a system recipient to perceive a hearing sensation resembling the natural hearing sensation normally delivered by the auditory nerve.

Such systems have typically comprised an external component and an
15 implantable internal component that cooperate together to provide the sound sensation to the user. The external component generally comprises a microphone for detecting sounds, such as speech and environmental sounds, a speech processor unit that converts the detected sounds, particularly speech, into a coded signal, a power source, such as a battery, and an external transmitter antenna. The coded signal is transmitted
20 transcutaneously to the internal component. The internal component comprises a receiver antenna, a receiver/stimulator unit, and an intracochlear electrode assembly.

The speech processor unit has traditionally been worn on the body, such as by being attached to clothing, or by being supported on the ear of the recipient. The
25 speech processor unit is relatively expensive and is relatively susceptible to damage, especially in the hands of infants or small children or when used in an unsuitable environment, such as in water. The present invention is directed to a cochlear implant hearing system that is potentially not so susceptible to damage in such circumstances.

Any discussion of documents, acts, materials, devices, articles or the like which
30 has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim
35 of this application.

Summary of the Invention

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated
5 element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

According to a first aspect, the present invention is an external component of a cochlear implant hearing system, the external component comprising:
10 a speech processor unit comprising a housing containing processing circuitry that receives signals output by a microphone; and
a protective case;
wherein the speech processor unit is removably mountable within the case and operable while mounted therein.

15 In this aspect, the case can comprise a base member and a relatively removable cover member. When the cover member is mounted to the base member, the case can be at least resistant to fluid ingress.

20 According to a second aspect, the present invention is a protective case for a speech processor unit of a cochlear implant hearing system, the case comprising:
a base member for removably receiving the speech processor unit; and
a relatively openable cover member.

25 In one embodiment of this aspect and wherein when the cover member is closed relative to the base member, the case can be at least resistant to fluid ingress.

In the second aspect, the speech processor unit can comprise a housing containing processing circuitry that receives signals output by a microphone.

30 In the first and second aspects, the speech processor can receive signals output from a first microphone that is mounted on or within the housing of the speech processor. In a further embodiment of the first and second aspects, the speech processor can be adapted to receive signals output from a second microphone. In this
35 regard, a first connector can be provided on the housing to allow transmission of the signals from the second microphone to the circuitry of the speech processor unit.

In the first and second aspects, the speech processor unit can be connectable to a power supply. In one embodiment, a second connector can be provided on the housing and/or the power supply to provide suitable electrical transmission between the power supply and the speech processor unit. Further discussion about the power supply is provided below.

According to a third aspect, the present invention is an external component of a cochlear implant hearing system, the external component comprising:

- 10 a speech processor unit comprising a housing containing processing circuitry;
- a first microphone mounted on or within the housing of the speech processor unit;
- a first connector for connecting the circuitry to at least a second microphone;
- and
- 15 a second connector for connecting the speech processor unit to a power supply;
- wherein the speech processor unit further comprises a power supply detection system that detects an identifying feature of the power supply.

In the third aspect, the speech processor unit can be removably mountable within a protective case. In this aspect, the case can comprise a base member and a relatively closable cover member. When the cover member is closed relative to the base member, the case can be at least resistant to fluid ingress.

In all of the aspects, the case can be adapted to prevent all fluid ingress, in particular water ingress, when the cover member is closed relative to the base member. In all of the aspects, the case can also be adapted to at least substantially prevent dust ingress when the cover member is closed relative to the base member.

In one embodiment, the cover member can be removably mounted to the base member. In another embodiment, the cover member can be hingedly mounted to the base member.

The case can contain at least one additional cover that overlies the speech processor unit, when the speech processor unit is mounted in the base member. The additional cover can be positioned beneath the cover member of the case. The additional cover can be formed from a relatively fluid-impermeable material. The

additional cover is preferably formed from a resiliently flexible material. The additional cover can also be transparent. The additional cover, when in position, can seal with a perimeter wall of the base member. In one embodiment, the additional cover can be formed from a polymeric or elastomeric material.

5

In one embodiment, the additional cover can have at least one orifice formed therein. If present, the orifice is preferably adapted to allow passage of a fixation device through the additional cover to assist in relatively holding the cover member of the case to the base member. In one embodiment, the fixation means can be a screw.

10

Once mounted on the base member, the cover member of the case can be held in this position by the screw, as described above, or another suitable fixation device. The screw can pass through an orifice in the cover member, a corresponding orifice in the additional cover and then relatively engage with the base member. A hollow post defining a threaded hole can receive the screw and serve to assist in locking the cover member to the base member.

While an embodiment that relies on one fixation device is described above, it will be appreciated that the case and additional cover could be modified to allow use of more than one fixation device.

20

Instead or in addition to the additional cover, a sealing ring can be provided around the perimeter of the base member or cover member to assist in preventing fluid and/or dust ingress into the protective case.

25

At the location of the fixation device, a seal can be provided to at least substantially prevent, and preferably prevent, ingress of fluid and/or water into the protective case at the site of the fixation device. The seal can be provided by an elastomeric grommet or washer.

30

The protective case can have at least one further orifice provided therein to allow entry into the case of a cable. This cable can extend into the case to the speech processor unit. In one embodiment, the cable can extend from the second microphone through the protective case and to the first connector that is mounted on the housing of the speech processor unit. In one embodiment, the second microphone can be mounted to a headpiece adapted to be worn by the recipient of the cochlear implant. The

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headpiece can further comprise an antenna that is adapted to at least transmit signals to a complementary antenna implanted within the recipient. In addition, the external antenna can be adapted to receive signals transmitted from the implanted antenna.

- 5 In one embodiment, the headpiece is preferably suitable for exposure to fluids, such as water. The headpiece can be formed in one-piece. The second microphone can be operable despite being exposed to water.

10 The external antenna can comprise an antenna coil and be part of a transcutaneous radio frequency (RF) link between the external component of the cochlear implant hearing system and an implanted component thereof. The coil can surround a magnet that is attracted to a complementary magnet implanted within the recipient. The magnetic attraction can serve to retain the external antenna, during use, in the desired position on the head of the recipient.

15 In a still further embodiment, the case can be formed of a metallic material, a ceramic material, a polymeric material, or some combination thereof. It will be appreciated that the cover member could be formed of a different material to that of the base member. In a still further member, the cover member and/or base member or parts thereof can be formed of a transparent or translucent material.

20 In another embodiment, the base member is adapted to removably receive the speech processor unit. One or more clips or other holding devices can be provided in the base member to hold the housing of the speech processor unit.

25 In one embodiment, the speech processor unit, despite being positionable within the case, is also adapted to be used by the recipient without the need to use the protective case. In this regard, the housing of the speech processor unit can be supported on the body and/or on the recipient's clothing. In one embodiment, the housing of the speech processor unit can have a shape and/or dimension that allows it to be supported behind the ear of the recipient. In this embodiment, the housing can engage with a detachable ear hook that extends over the ear and supports the majority of the housing behind the ear. If the recipient desires to use the protective case, the ear hook can be detached prior to the placement of the speech processor unit within the case.

When used outside the case, the speech processor unit can rely on a power supply that engages with the housing. As such, when used in this manner, the cochlear implant system relies on an external component that is supported on the ear of the recipient. This power supply can comprise one or more batteries and can be
5 rechargeable.

In the third aspect, the speech processor unit comprises a power supply detection system that detects an identifying feature of the power supply. In one embodiment, the speech processor unit of the first and second aspects can also comprise such a power
10 supply detection system. Where present, the identifying feature of the power supply can comprise a pin extending from the power supply, hereinafter called the ID pin. The ID pin is preferably adapted to engage with a suitable socket formed in the housing of the speech processor unit. The ID pin can be part of the second connector for
15 connecting the speech processor unit to the power supply. The power supply is also preferably provided with a voltage supply pin and a ground pin that are also adapted to engage with complementary sockets in the housing of the speech processor unit. It will be appreciated that instead of the power supply having pins and the housing having
20 sockets, the housing can have pins that are adapted to engage with sockets in the power supply. Still further, it will be appreciated that the both the housing could have one or more pins and sockets and the power supply one or more pins and sockets to provide the second connection between the power supply and the speech processor unit.

In one embodiment, the power supply detection system can comprise a circuit that measures the resistance between the ID pin (or socket) and ground pin (or socket)
25 of the power supply connected to the speech processor unit. In this regard, different power supplies can be provided with different such resistances so acting as an identifying feature for the speech processor unit which can identify which type of power supply is connected thereto.

Where the speech processor unit is to be operated in a manner such that it is placed behind the ear (BTE), the recipient or their carer, will connect an appropriate power supply to the speech processor unit, eg a BTE power supply, to allow the speech processor unit to be used in that position. On detecting that a BTE power supply is connected thereto, the speech processor unit can be adapted to preferentially rely on use
35 of the first microphone mounted in or on the housing.

When the recipient or their carer wishes the speech processor unit to be protected by the case, the BTE power supply, if in position, is detached from the housing and electrical connection is made with a power supply that is also mountable within the case. This case-mountable power supply can comprise one or more batteries and can also be rechargeable. The batteries can be relatively less expensive than the batteries used in the BTE power supply. The protective case thereby provides the recipient or their carer with a potentially advantageous option of using a less expensive power supply, when and if desired. This power supply can have a pin (or socket) connector as already described and will typically have a different resistance between its ID pin (or socket) and ground pin (or socket) to that of the BTE power supply. On detecting that the case-mountable power supply has been connected, the speech processor can be adapted to preferentially rely on use of the second microphone mounted to the cable extending into the case from, for example, the headpiece.

Where the case-mountable power supply comprises one or more rechargeable batteries, the case can contain charging circuitry so allowing the batteries mounted within the case to be recharged when the case is not in use.

In one embodiment, the speech processor unit can further comprise one or more performance indicators. In one embodiment, the indicator can comprise a liquid crystal display (LCD) that can display performance criteria, such as battery charge state, memory state, and other criteria. Instead of or in addition to the LCD display, the speech processor unit can have at least one light emitting diode (LED) connected thereto. In one embodiment, when the LED is lit, the speech processor unit can be regarded as operating normally. The LED can be visible despite being in the case if the case is transparent or translucent, at least in the location of the LED. In another embodiment, the LED can be mounted in the wall of the case and connected through appropriate electrical wiring to the speech processor unit when it is mounted in the case.

The case can further enclose an alarm system. The alarm system can be set up to actuate on opening of the case. In another embodiment, the alarm can actuate when the transcutaneous RF link fails, such as by displacement of the external antenna. The alarm can comprise a sound generating device, such as a buzzer. In another embodiment, the alarm system can transmit a signal that is detectable by a remote control. In this case, the remote control can have a sound generating device or

vibrating device that activates to inform the holder of the remote control that there is at least a potential problem with the hearing system. The alarm system preferably incorporates a switch that can deactivate the alarm.

- 5 In one embodiment, the user interface for the speech processor is mounted on the housing thereof. In this embodiment, it is preferred that the interface is not accessible while ever the speech processor unit is within the case.

- 10 Whilst the user interface is in the case, the speech processor can have an activation and/or deactivation system that can be operated when required by the recipient or a carer.

- 15 In one embodiment, the deactivation system can comprise a switch contained within the housing of the speech processor and connected between the power supply and the speech processor. The switch can be responsive to the presence of a transmitting device that transmits signals. In one embodiment, the switch is a magnetically responsive switch which responds to a magnetic field generated by the transmitting device. In this embodiment, the switch can respond in the presence of a magnetic field of a certain strength. In one embodiment, the certain strength is the strength of the magnet that is typically part of the headpiece. The action of removing the headpiece and bringing it adjacent the cover member, for example, of the case, activates the switch and so shuts down the speech processor. One example of such a switch is described in the present applicant's co-pending Application No 2003904085, the contents of which are incorporated herein by reference.

25

- 25 In another embodiment, a deactivation system can operate when the transcutaneous RF link has been broken. In this embodiment, the speech processor unit can periodically transmit a RF signal and look for a response from the implantable component. Where no response is present, the speech processor can go into a standby mode. Even in this mode, the speech processor unit can periodically transmit a RF signal. If a response is noted, the speech processor can fully activate and start processing sound and retransmit full signals to the implantable component.

30

- 35 In yet another embodiment, the activation and/or deactivation system can comprise a switch mounted on the case.

In a still further embodiment, the speech processor can be adapted to shut down whenever the power supply is being charged.

5 In yet another embodiment, the activation and/or deactivation system can rely on use of a remote control operated by the recipient or their carer that is able to transmit appropriate signals to the speech processor when it is mounted within the case.

10 In another embodiment, the protective case can be adapted to prevent tampering and/or adjustment of the speech processor when it is mounted in the case. The case can, for example, be resistant to opening, at least by children.

The external components as defined herein are adapted to operate in conjunction with an implantable component. The implantable component comprises a housing for a stimulator unit that outputs stimulation signals based on inputs delivered from the
15 external speech processor, a receiver antenna that is part of the RF link, and an electrode assembly that applies electrical stimulation to the cochlea in accordance with the output of the stimulator unit.

20 The present invention provides a system that can be used by infants, children and adults.

Brief Description of the Drawings

25 By way of example only, a preferred embodiment of the invention is now described with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of a BTE speech processor unit;

30 Fig. 2 is a perspective view of an external component of a cochlear implant hearing system according to the present invention with the BTE speech processor unit of Fig. 1 depicted mounted in a protective case;

Fig. 3 is an exploded perspective of the external component of Fig. 2;

35 Fig. 4 is a schematic of the signal and electrical connections made with the BTE speech processor unit;

Fig. 5 is a schematic of the battery detection circuit of the BTE speech processor; and

5 Fig. 6 is a schematic view of the BTE speech processor unit mounted in the protective case.

Preferred Mode of Carrying out the Invention

10 One embodiment of an external component of a cochlear implant hearing prosthesis according to the present invention is depicted generally as 10 in Figs. 2 and 3.

15 In the depicted embodiment, the component 10 comprises a speech processor unit 11 that is removably mounted within a protective case 12. While the speech processor unit 11 is able to be mounted within the case 12, it is also capable of operating in a stand-alone manner as depicted by Fig. 1.

20 In Fig. 1, the speech processor unit 11 is shown as having a housing 13 that contains therein signal processing circuitry. In operation, a cable, such as cable 26 depicted in Fig. 2, extends from the unit 11 to a headpiece. A detachable ear hook 14 is provided at one end of the housing 13 so as to allow the housing 13 to be supported behind the outer ear of the recipient of the cochlear implant. At an end distal the ear hook 14, a power supply comprising a rechargeable battery 15 is clipped to the housing
25 13. The unit 11 utilises a built-in microphone 16 (see Fig. 4) that outputs signals to the processing circuitry within the housing 13.

30 While the speech processor unit 11 is capable of operating in a stand-alone manner, it is susceptible to damage from rough handling, such as might be experienced when used by infants or small children. It is also not suitable for use in adverse environments, such as high dust environments or if exposed to excessive moisture.

Fig. 2 depicts how the speech processor unit 11 can still be used by infants or small children or in what have hitherto been unsuitable environments for the unit.

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The depicted case 12 is resistant to fluid ingress for at least a period of time. The case 12 comprises a base member 17 and a removable cover member 18. As depicted, the cover member is transparent thereby allowing the recipient, or their carer, to view the interior of the case 12. The base member 17 can be formed of a metallic material, a ceramic material, a polymeric material, or some combination thereof.

The depicted case 12 contains an additional cover 19 (see Fig. 3) that is positioned within the case 12 and overlies the speech processor unit 11, when the speech processor unit 11 is mounted in the base member 13. The additional cover 19 is formed from a fluid-impermeable, transparent and resiliently flexible material. The additional cover 19, when in position, seals with a perimeter wall of the base member 17.

As depicted, the additional cover 19 has an orifice 21 formed therein that is adapted to allow passage of a fixation screw 22 through the additional cover 19 to assist in relatively holding the cover member 18 of the case to the base member 17.

Once mounted on the base member 17, the cover member 18 of the case is held in this position by the screw 22. The screw 22 passes through an orifice 23 in the cover member 18, the corresponding orifice 21 in the additional cover 19 and then is engageable with the threaded hole of post 24.

At the location of the screw 22, an elastomeric grommet 25 is provided to help prevent ingress of water into the protective case at the site of the screw 22.

The protective case 12 has a further orifice provided therein that allows entry into the case of a cable 26. The cable 26 extends from a one-piece headpiece 27 into the case 12 to the speech processor unit 11. A grommet 33 is provided around the cable 26 to prevent water entering the case at the cable location. A second microphone 34 (see Fig. 6) is mounted to the headpiece 27. The headpiece 27 comprises a coil antenna that is adapted to at least transmit signals to a complementary antenna implanted within the recipient. In addition, the external antenna is adapted to receive signals transmitted from the implanted antenna.

The headpiece 27 and the second microphone 34 mounted thereon are also suitable for at least some exposure to fluids, such as water.

The external antenna of the headpiece 27 is part of a transcutaneous radio frequency (RF) link between the external component 10 of the cochlear implant hearing system and an implanted component thereof. The coil surrounds a magnet 28 that is
5 attracted to a complementary magnet implanted within the recipient. The magnetic attraction serves to retain the external antenna, during use, in the desired position on the head of the recipient.

The interior of the base member 17 removably receives the speech processor
10 unit 11. One or more clips are provided in the base member 17 to hold the housing 13 of the speech processor unit 12 in place.

The speech processor unit 11 can be connected to more than one type of power supply. When used alone, in the configuration depicted in Fig. 1, the unit 11 is
15 powered by a power supply 15. In contrast, when positioned within the case 12, the ear hook 14 and power supply 15 are firstly removed. Electrical connection is then made with an on-board power supply 29 mounted within the case 12.

The depicted speech processor unit 11 incorporates a power supply detection
20 system that detects an identifying feature of the power supply and so allows the unit 11 to recognise when it is being used in the case (such as is depicted by Fig. 2) and when it is being used in a stand-alone mode (such as is depicted by Fig. 1).

In the depicted embodiment, the identifying feature of the power supply is an ID
25 pin 35 (see Fig. 5) extending from the power supply. The ID pin 35 is engageable with a suitable socket formed in the housing 13 of the speech processor unit 11. The power supply is also provided with a voltage supply pin 36 and a ground pin 37 that are also adapted to engage with complementary sockets in the housing 13 of the speech processor unit 11.

30

In the embodiment depicted by Fig. 6, the power supply detection system comprises a circuit 31 that measures the resistance between the ID pin 35 and the ground pin 37 of the power supply connected to the speech processor unit 11. In this regard, different power supplies are provided with different such resistances so
35 providing the speech processor unit 11 with the capability to identify which type of power supply is connected thereto.

Where the speech processor unit is to be operated in a manner such that it is placed behind the ear (BTE), the recipient or their carer, will connect power supply 15 to the speech processor unit to allow the speech processor unit 11 to be used in that position. On detecting that the power supply 15 is connected thereto, the speech processor unit 11 preferentially relies on use of the first microphone 16 mounted in or on the housing 13.

When the recipient or their carer wishes the speech processor unit 11 to be protected by the case 12, the ear hook 14 and the power supply 15 are detached from the housing 13 and electrical connection is made with the power supply 29 that is mountable within the case 12. As with the power supply 15, the case-mountable power supply 29 comprises a rechargeable battery having an ID pin 35, a ground pin 37 and a voltage supply pin 36. On detecting that the case-mountable power supply 29 has been connected, the speech processor unit 11 then preferentially relies on use of the second microphone 34 mounted to the headpiece 27.

The case 12 also can contain charging circuitry so allowing the power supply 29 to be recharged when the case 12 is not in use.

The speech processor unit 11 further comprises a liquid crystal display (LCD) and/or one or more LEDs that display performance criteria of the unit 11, such as battery charge state, memory state, and other criteria.

The case 12 further encloses an alarm system 32. In the depicted embodiment, the alarm system comprises a buzzer that actuates when the transcutaneous RF link fails, such as by displacement of the external antenna. The alarm system incorporates a switch 33 that can be thrown to deactivate the alarm 32.

The user interface (eg. program selection, volume control) for the speech processor unit 11 is mounted on the housing 13 thereof. The interface of unit 11 is not accessible while ever the speech processor unit 11 is within the case 12.

Whilst the user interface is in the case 12, the speech processor unit 11 or case 12 incorporates a deactivation system that is operated when required, whether it by the recipient or a carer. An activation system can also be provided.

One example of a deactivation system is a reed switch that is responsive to a magnetic field. In this embodiment, the speech processor unit 11 is disconnected from the power supply when the magnetic field of the magnet 28 within the headpiece 27 is brought to a location adjacent the switch.

Other deactivation systems can be envisaged to operate when the transcutaneous RF link has been broken. For example, the speech processor unit 11 can periodically transmit a RF signal and look for a response from the implantable component. Where no response is present, the speech processor unit 11 can go into a standby mode. Even in this mode, the speech processor unit 11 can periodically transmit a RF signal. If a response is noted, the speech processor unit 11 can fully activate and start processing sound and retransmit full signals to the implantable component.

Still further, the deactivation system can comprise a switch mounted on the case. The speech processor unit 11 can also be adapted to shut down whenever the power supply 29 is being charged.

Finally, the deactivation system can rely on use of a remote control operated by the recipient or their carer that is able to transmit appropriate signals to the speech processor unit 11 when it is mounted within the case.

The external component 10 as depicted operates in conjunction with an implantable component. The implantable component comprises a housing for a stimulator unit that outputs stimulation signals based on inputs delivered from the external speech processor, a receiver antenna that is part of the RF link, and an electrode assembly that applies electrical stimulation to the cochlea in accordance with the output of the stimulator unit.

In the case of adults, the present invention provides a recipient with the flexibility of using their speech processor unit 11 in a moist environment. For infants and small children, the present invention also can be used in the comfort that the speech processor is less likely to be damaged than would be the case where the speech processor unit is used in the stand-alone mode. The case 12 is also potentially advantageous in that it can serve to assist in preventing tampering of the speech processor 11 by a child recipient or a third party.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly
5 described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

Dated this twenty fourth day of December 2003

Cochlear Limited
Patent Attorneys for the Applicant:

F B RICE & CO

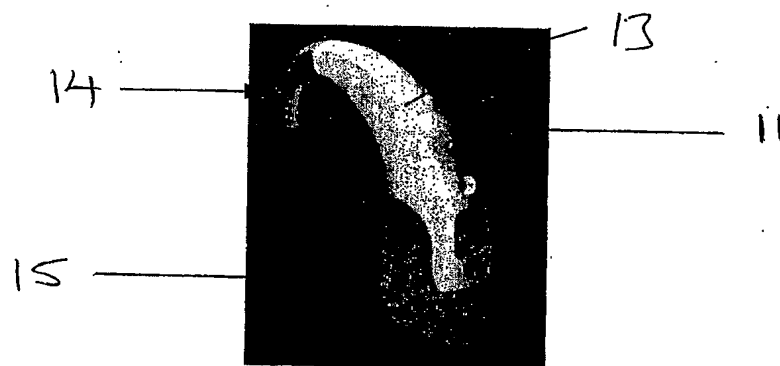


Figure 1

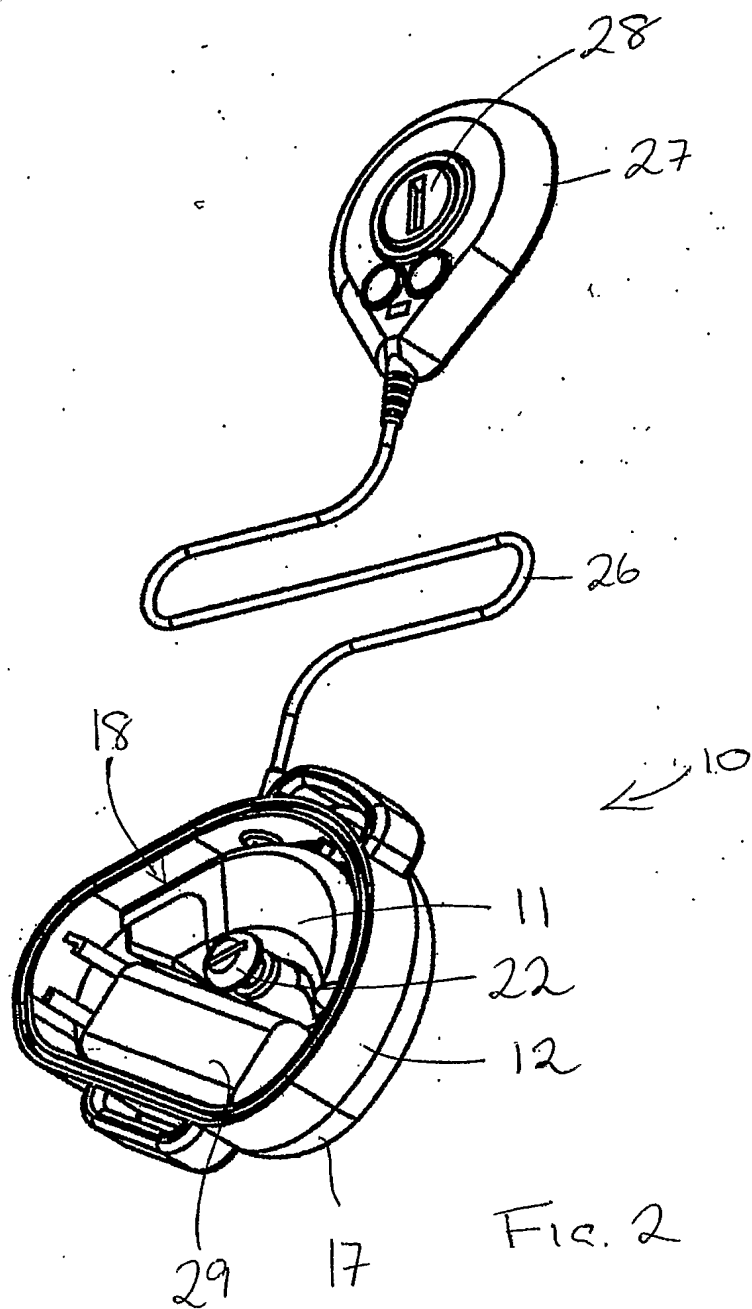


FIG. 2

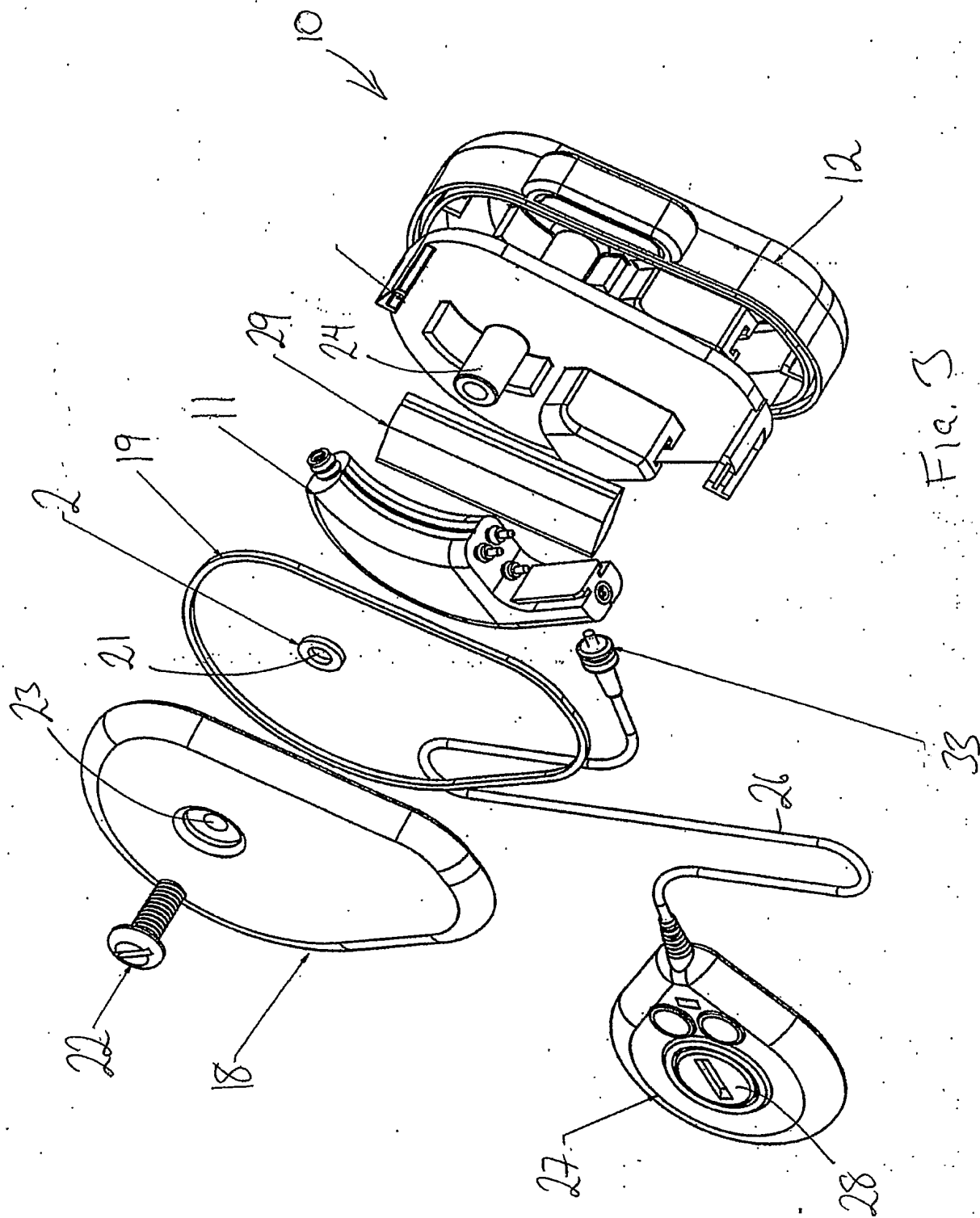


FIG. 3

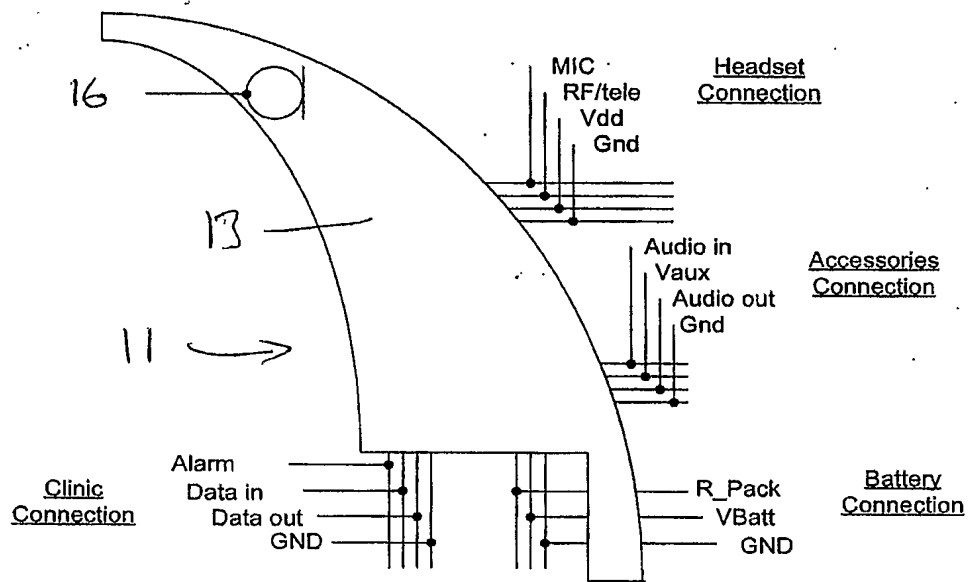


Figure 4

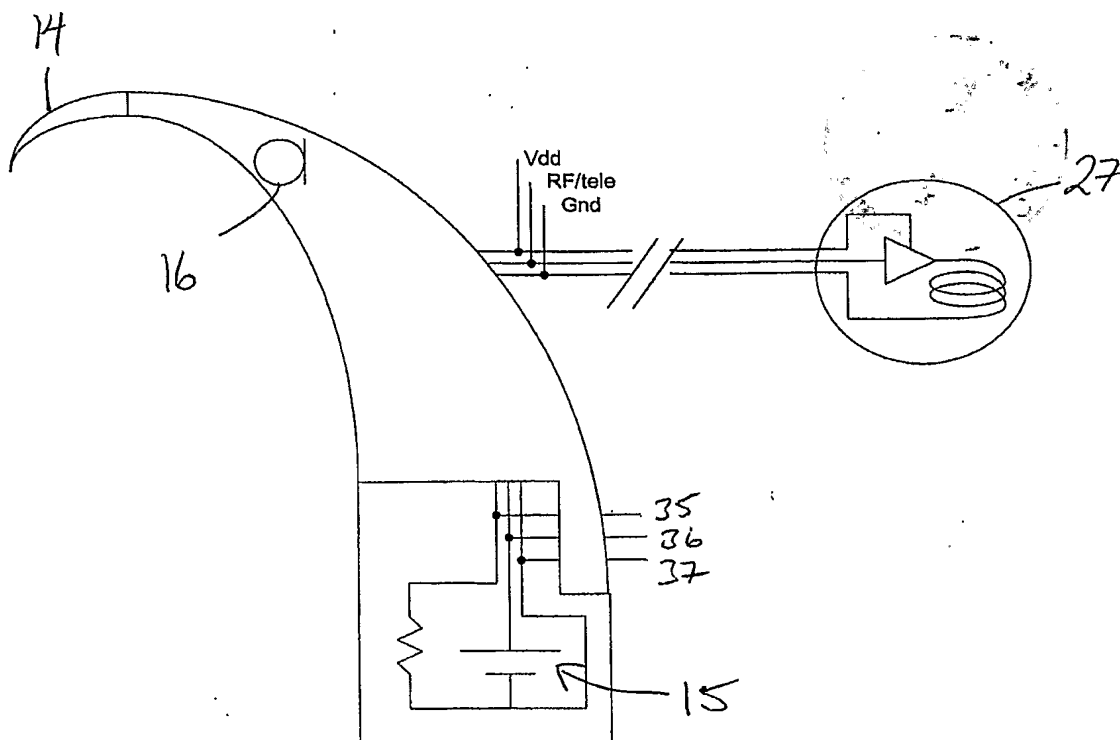


Figure 5

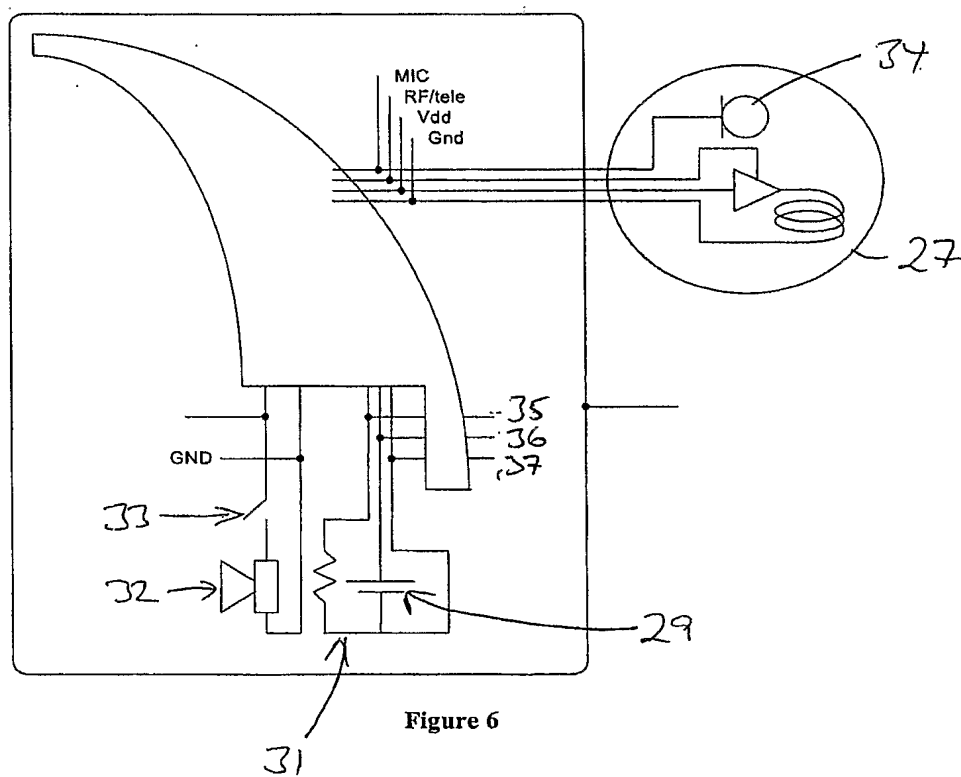


Figure 6